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Research Article

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Abstract

OBJECTIVE
The aim was to examine how parental cancer affects the mental health of offspring aged 6–30, and age variations in this effect.

METHODS
Individual fixed-effects models were estimated from register data covering the entire Norwegian population in 2010–2018. The outcome variable was whether the individual (offspring) had at least one consultation within a year with a general practitioner (GP) or specialist where a mental health diagnosis or symptom was reported.

RESULTS
The consultation probability was higher after a parental cancer diagnosis than before (e.g., 15% higher in the first year after the diagnosis). This was to a large extent driven by subsequent parental deaths, but there was also a small post-diagnosis increase among offspring whose parent survived the observation period. The consultation probability increased by 83% the year a parent died among offspring who were 19–30 at that time, after a smaller increase over a few of the preceding years. A decline occurred later. The death seemed to have a weaker, but more lasting, effect on those who were 8–18 years old at the time of the death, and these did not experience a clear pre-death increase.

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CONCLUSION
Parental cancer death seems to weaken offspring's mental health – and no less among young adults than among children. By contrast, having a parent with cancer who remains alive at least throughout the observation period has relatively little impact.

CONTRIBUTION
We show associations between parental cancer and offspring's mental health, paying special attention to whether the parent dies. This may inform discussions about supporting offspring.

1. Introduction

In demography and other social sciences there has been much interest in how parental resources, family stability, and other aspects of the early-life environment affect children's health and development (Bradley and Corwyn 2002; Heckman 2012; Kravdal and Wörn 2023), their demographic behaviour (Wiik 2009), and their own socioeconomic resources as adults (Hällsten and Thaning 2022). However, when analysing these effects of family background, social scientists have paid little attention to serious parental illness, and when they have the focus has often been on socioeconomic consequences (Aaskoven, Kjær, and Gyrd-Hansen 2022) rather than health.

Our goal is to add to the knowledge of how parental illness and death influence the mental health of children and young adults over roughly a decade (which in turn may have an impact on later life outcomes). We focus on cancer, which is the most common cause of death in the age group where people typically have relatively young children (Norwegian Institute of Public Health 2018). According to Norwegian data, 6% of individuals born in the 1990s had experienced a parental cancer diagnosis by the age of 18 (own calculations). The medically oriented literature includes many investigations aimed at quantifying the health effects of parental cancer, but these have often been based on small-scale surveys, and many potentially important confounders have not been controlled for (see review below). The conclusions have also been rather diverse.

Our study is based on register data that cover the entire Norwegian population and include information about healthcare use. It focuses on offspring who experienced a parental cancer diagnosis or death when aged 8–30, and their mental health from age 6 to 30 as indicated by whether they have had a consultation with a general practitioner (GP) or specialist where a mental health problem was reported. The analysis covers the years 2010–2018.

We estimate individual fixed-effects models to control for time-constant factors (including unobserved factors) that may affect both the probability of parental cancer and

the offspring's health, and take a dynamic perspective in the sense that we consider the importance of time since diagnosis or death. This methodology has, to our knowledge, been used only once before in research on how parental cancer affects children's health (Kristiansen 2021). However, in that study only the effects of a cancer diagnosis were estimated, without taking into account whether the diagnosis was followed by death; effects of cancer deaths were not estimated. Often the statistically less advanced investigations also fail to distinguish between parents who are still alive after a cancer diagnosis and those who have died (Howell et al. 2016).

In our study we attempt to separate the effects of a death or a forthcoming death from the other effects of cancer. We do this by estimating models for effects of parental cancer death as well as models for effects of parental cancer diagnosis, and by conditioning the latter on whether and when the parent dies. The effects of the cancer diagnosis among those whose parent does not die within the next few years, or perhaps survives through the whole remaining observation period, may be considered as reflecting the disease consequences that are not due to the death. For the subgroup with a surviving parent we also check how the effects of the diagnosis vary with the prognosis, as indicated by published site- and stage-specific 5-year relative survival rates. Healthcare personnel often provide the patient and the family with information about the prognosis, and it is possible that this information influences mental health even in a phase of the disease when the current health situation is not very bad.

In addition to analysing the overall effects of parental cancer and the variation according to survival prospects, we examine how the effects vary according to the offspring's age by estimating most models separately for two broad age groups. As further discussed below, the effects of parental cancer might be expected to be particularly detrimental to young offspring who are still very dependent on parental support – although there are also some relevant counterarguments.

2. Background

2.1 Research motivation

Knowledge about the effects on mental health of having a parent with cancer – and possibly losing that parent – may be important in discussions about support. Typically, family members and friends will try to help, but in many countries there are also more formal support systems. In Norway, institutions treating cancer patients are obliged by law to evaluate the situation for children younger than 18, and to offer various types of assistance if considered necessary. This is also the case (since 2018) after a death (Ministry of Health and Care Services 2023). However, it has been reported that the

support is often of quite low quality (Norwegian Cancer Association 2019), and there are no similar formal obligations with respect to young adult offspring. The further development of such support programmes should ideally be based on empirical evidence about the various types of challenges that the offspring of cancer patients tend to meet. Such evidence may also be of value to sick parents and their co-parents, who are likely to be very concerned about their children.

2.2 Brief review of observed patterns and possible mechanisms

Earlier empirical research on the health effects of parental cancer includes both qualitative and quantitative studies – many based on small and not always nationally representative surveys. Some of these studies suggest a relatively high probability of, for example, distress, anxiety, depression, or various psychosomatic symptoms among children of parents with cancer (see reviews by Morris, Martini, and Preen 2016; Visser at al. 2004). Studies focused largely on cancer that was not at an advanced stage point in the same direction (Osborn 2007). These mental responses may be partly due to a fear of loss. Furthermore, offspring may receive less support and attention from the parent who is ill – and who may be struggling with pain and fatigue and spend considerable time in treatment – or from the co-parent, who may be very worried and carry a heavy care burden. The offspring may also be influenced by various other changes caused by the illness, possibly including a reduced family income.

However, there are also studies that find no negative effects on children's health, or even indications of health advantages (see also Jeppesen et al. 2013; Visser et al. 2007). One possible explanation is that parents with a severe disease are particularly eager to spend time with their children, as far as they are able (Semple and McCance 2010). Friends and other family members may also be very supportive, and there may be aspects of the situation that constitute some sort of 'growth experience' (Bultmann et al. 2014).

Obviously, the situation changes if the parent dies. On the one hand, care tasks that may have been quite burdening disappear. On the other, the offspring and other family members may enter a period of intense grief, and the definitive loss of a parent may cause life changes with long-term health implications through complex causal chains involving, for example, education. Many investigations have indeed shown that offspring's health and wellbeing are adversely affected by parental deaths from cancer (Jessopp, Fischer and Good 2022) or a broader group of causes (Berg, Rostila and Hjern 2016; Glaser and Pruckner 2023), although there are also studies where such effects have not appeared (Pfeffer et al. 2000; Stikkelbroek et al. 2012).

The situation shortly before death may also be particularly difficult for the offspring, as the problems earlier in the illness period become aggravated (Jessopp, Fischer, and

Good 2022). In particular, less pronounced worries about the outcome in the beginning may be replaced by 'anticipation grief', and the parent with cancer is likely to need even more support than before. In cases where the family is informed about poor survival possibilities at the time of diagnosis or soon afterwards (based on cancer site and stage), the offspring may enter a period of intense anxiety very early, long before the death.

Children and young adults may gradually adapt to the loss of a parent, partly through the development of alternative sources of support, and experience an improvement in health compared to the period around the time of death. However, it is also possible that the loss starts a chain of events with long-term adverse consequences (Kravdal and Grundy 2016).

2.3 The modifying effect of age

The relevance or importance of the various types of response to a parental cancer diagnosis or death likely varies with the offspring's age. However, the direction of this variation is not obvious. On the one hand (and in line with the so-called attachment theory; Bowlby 1977), the loss of or reduced contact with a parent because of cancer may be particularly detrimental to young children because of their extreme dependence on parental support (Leopold and Lechner 2015). On the other, adult offspring will feel more responsible for helping the sick parent – and the co-parent. Moreover, even though they may earn money and have established their own family, they may still be emotionally close to their parents and (in the absence of parental illness) be net receivers of various types of support (Swartz et al. 2011). Furthermore, they may be better able to understand the severity of the situation than, in particular, the youngest children. Finally, the experience of stressful events in young adulthood may affect transitions to tertiary education and establishing careers, with potential long-term consequences (Porter and Claridge 2021). Reviews of studies on the effects of parental cancer on offspring's health and well-being have concluded that while the exact nature of the response may differ by age, the existing evidence does not suggest a difference in the overall impact (Hoffmann, Kaiser, and Kersting 2018; Krattenmacher et al. 2012; Morris, Martini, and Preen 2016; Osborn, 2007).

2.4 Evidence from register-based studies

In recent years some parental cancer studies have been based on nationwide register data (Inhestern et al. 2021). The use of such data hugely increases the number of observations and allows other and quite objective health measures to be considered. Using Danish

register data, Kristiansen (2021) and Momen et al. (2018) find that having parents with cancer (who perhaps die from it) is linked to a higher probability of certain mental disorders. Another Danish study shows that parental death from cancer affects the use of psychotropic medication, at least during the first six months after the death, while living with a parent who has cancer has less impact (Høegh et al. 2021). Benros et al. (2013) observe adverse mental health effects on Danish offspring of cancer patients even when censored at the time of death (if any). Poorer mental health among children experiencing parental cancer has also been shown in Sweden, especially after parental death (Chen et al. 2018a). Similarly, Finnish register-based studies have shown an excess risk of psychiatric disorders (Niemelä et al. 2012, 2016). One of these Nordic investigations indicates that the youngest offspring experience the most adverse consequences (Niemelä et al. 2012), one points weakly in the opposite direction (Chen et al. 2015a), and one shows no age difference (Chen et al. 2015b).

As one would expect, some authors have reported that parental cancer is particularly harmful to offspring when survival prospects are poor, although this may reflect that the parent is also likely to have actually died (Chen et al. 2018a, 2018b). However, there are also investigations showing no such relationship with survival prospects (Chen et al. 2015b).

Among these register-based studies of effects of parental cancer, the methodology of Kristiansen (2021) – based on Danish data – stands out. She takes a step away from the 'standard' regression approach by estimating individual fixed-effects models. Such models take into account all joint determinants of parental cancer and offspring health that are time-constant by utilizing the within-offspring variation in health outcomes across time. Essentially, health outcomes after the cancer diagnosis are compared to those before this event for the same individual. Unlike earlier studies of the health effects of parental cancer, Kristiansen analyses how these effects vary by time from diagnosis. However, as mentioned above, she does not take into account whether the diagnosis was followed by death, and she estimates the effects of all deaths pooled together without considering the cause of death or previous diagnoses.

3. Data

The key data sources were the Norwegian Population Register, the Cause-of-Death Register, the Cancer Register, the Control and Distribution of Health Reimbursement database (KUHR), and the Norwegian Patient Register (NPR). The data extraction for the analysis covered the period up to 1st January 2019.

Everyone who has ever lived in Norway after 1964 is included in the Population Register and is assigned a personal identification number (PIN) that allows linkage to

other registers. The Population Register includes information about the person's date of birth and death (if any). PINs of parents are included for almost everyone born in Norway after 1953. The word 'parent' refers to the social parent in the quite rare cases when an adoption has taken place. Furthermore, there is annual information on whether the person was living in Norway on the 1st January. The Cause-of-Death Register includes information about the causes of all deaths since 1964.

The Cancer Register includes information on the date of diagnosis, cancer site, and stage at the time of diagnosis for all cancers diagnosed after 1964, while the KUHR includes information about consultations with GPs and other primary healthcare personnel from 2006 onwards. Only a few GPs in Norway do not report their consultations in the KUHR (because they do not have a contract with the health authorities). The NPR includes information about use of specialized healthcare and covers the period from 2008 or 2009. Notwithstanding, due to under-registration in the beginning, our analysis starts in 2010.

Our outcome variable is whether the offspring had – within a year – at least one face-to-face GP consultation where a symptom or diagnosis of a mental health problem was reported (ICPC-2 codes P01-P99), or at least one specialist consultation where a mental disorder (ICD-10 codes F01-F99) was reported as a main or secondary diagnosis. We often refer to this below as 'had a consultation for a mental disorder'.

4. Methods

4.1 General issues

The analysis was restricted to individuals for whom both the mother's and father's PIN were included in the Population Register, and who were born in 1980–2010 (i.e., they were 30 years old or younger in 2010, which is the first year covered by the analysis, and 8 years or older in 2018, which is the last year). For each individual (offspring), a first (FYO) and last (LYO) year of observation were defined. The FYO is 2010, or if the individual then lived abroad or was not yet 6 years old, the first year after 2010 when the individual lived in Norway on 1st January and had already turned 6 or did so within the year. Consequently, the age of the individual (defined as their age at the end of the year) was at least 6 in the FYO. The LYO is 2018, the year when the individual turned 30, or the year before the individual died or emigrated, whichever came first. In this way only the years when the individual lived in Norway at both the beginning and end of the year were included. The outcome variable (whether there has been a healthcare consultation within a year) is then a particularly relevant indicator of the individual's health in that year.

We conducted three types of analyses (see overview in Table 1). The aim of Analysis I was to assess the impact of a parental cancer diagnosis, and the key independent variable was the time since diagnosis. In Analysis II the focus was instead on changes in consultations around the parental cancer death, so time since death was the key variable. Analysis III (like Analysis I) focused on changes after the cancer diagnosis – and on the time-since-diagnosis variable – but the analysis was conditioned on cancer death or survival. Analysis I provides information about the offspring's response to having a parent who is more or less seriously affected by cancer, or who may already have died from cancer. As mentioned above, most earlier studies take this relatively broad perspective. By contrast, Analysis III sheds light specifically on the consequences of a parental cancer that has not (within the observation period) led to death. Note that whether the parents live together is not taken into account in any of the analyses.

Table 1: Overview of the analyses

Type of analysis	Groups included [a]	Figure and tables [b]
I Effects of diagnosis	Offspring experiencing parental cancer diagnosis (A) + Age control group (B)	Effects shown in Figure 1 and (with all years before the diagnosis pooled together) in the first column of Table 3
II Effects of death	Offspring experiencing parental cancer death (A*) + Age control group (B)	Effects shown in Figure 1
III Effects of diagnosis, conditioned on survival/death	Offspring experiencing parental cancer diagnosis (A) + Age control group (B), but A conditioned on whether survival or time of death	Effects shown in the second and third columns of Table 3 (all years before the diagnosis pooled together) and in Table 4 (all years before the diagnosis pooled together and broader categories for years after the diagnosis) Table 5: Restricted to individuals whose parent did not die from cancer and interaction with relative survival added (all years before the diagnosis pooled together and broader categories for years after the diagnosis)

Notes: [a] See text for definitions of Groups A, A*, and B.
[b] Appendix tables show estimates from many different types of models, which are specified in the table headings or the footnotes to the tables.

4.2 Analysis I: Effects of parental cancer diagnosis

Two groups of offspring were included in the analysis of the effects of time since parental cancer diagnosis, one that experienced a parental cancer diagnosis (group A) and – for reasons explained below – one that did not (group B). More specifically, group A consists of those who have

1) one parent who received a first cancer diagnosis between FYO+2 and LYO, and who may or may not have died from that cancer before or in the LYO, but who

did not have another cancer diagnosis in this period (generally, about 10% of Norwegians diagnosed with a first cancer have a second cancer later in life), and who did not die from another cause, while

2) the other parent had neither been diagnosed with cancer nor died up to the LYO.

Note that cancer may also have been an important underlying cause for some of those who are registered as having died from something else, as there is sometimes doubt about which cause would be most reasonable to register. However, this is unproblematic from our perspective since the group is very small (being a subgroup of the 2% that are excluded because cancer is not the registered cause of death). Note also that it is extremely uncommon for children and young adults to have two parents with a cancer diagnosis.

All the offspring in group A contribute observations in the year of the cancer diagnosis, possibly years after the diagnosis (if the diagnosis was in LYO–1 or earlier), the year before the cancer diagnosis (chosen as a reference category for the time-since-diagnosis variable; see below), and at least one year before that. The latter means that they contribute to the estimation of the pre-diagnosis trend. Note that since the FYO is not earlier than the year when the offspring turned 6 years old, the lowest possible age at diagnosis is 8 years.

Group B (also described below as the 'age control group') consists of offspring whose mother and father were neither diagnosed with cancer nor died from any cause up to the LYO.

The following linear probability model was estimated from information for offspring in groups A and B:

$$Y_{it} = \Sigma_{k=-8,6}\, \beta_k D^{(k)}{}_{it} + \gamma \boldsymbol{A}_{it} + v_i + \varepsilon_{it}$$

Y_{it} is 0 or 1, depending on whether offspring i had a healthcare consultation for a mental disorder in year t (t between FYO and LYO), and $D^{(k)}{}_{it}$ are dummy variables corresponding to year k since diagnosis (negative before the diagnosis). We set $k = -1$ as the reference category. As pointed out and motivated below, other categorizations of D were used in parts of the analysis. In addition, a vector $\boldsymbol{A}_{it}$ of age dummy variables for 1-year categories of offspring's age was included to take into account that the offspring becomes older as time since diagnosis increases. Offspring fixed effects are represented by v_i. The estimation was done with the *xtreg* command in Stata, using the *fe* option and robust standard errors clustered at the individual level.

Note that when the model is linear it is easier to assess the importance of mediators (not relevant here) and interactions (Ai and Norton 2003; Karlson, Holm, and Breen 2012) than if the analysis is based on a logistic or other non-linear model.

Group B was included because there would have been a linear dependence problem if the estimation had been based exclusively on offspring in group A. This linear dependence arises because current age minus time since diagnosis is the age at diagnosis, which is constant over all observations for an individual and can be seen as part of the fixed effect. If models had only been estimated from group A, it would not be possible – because of the linear dependence – to separate effects of age and time since diagnosis without making assumptions about either age or time since diagnosis having no effect within a certain interval of these variables (as Kravdal, Wörn, and Reme (2023) illustrate for a similar situation). Offspring in group B only contributed to the estimation of the age effect (for these individuals, all the *D* dummy variables were set to zero; i.e., they were in the reference category of *D*). The underlying assumption behind this approach is that the age effect in group B is the same as among those who have experienced a cancer diagnosis (group A). This assumption is further discussed below.

We stratified by the offspring's age when the parent was diagnosed with cancer. In this stratified analysis, a subgroup of A that was defined according to the offspring's age at the time of diagnosis (8–18 years old or 19–30 years old) was included along with group B. For simplicity, the subgroups are referred to below as 'the youngest group' and 'the oldest group'.

4.3 Analysis II: Effects of parental cancer death

When focusing on time since parental death from cancer, a group A* was included instead of A. We used the same criterion 2 for inclusion in group A* as for A, but criterion 1 was changed to the following: the offspring must have one parent who died from cancer between FYO+2 and LYO, and there must have been one cancer diagnosis for that parent, no earlier than the year after the offspring's birth. This analysis of cancer death was also age-stratified, but now according to the offspring's age when the parent died from cancer.

4.4 Analysis III: Effects of parental cancer diagnosis, conditioned on whether the parent subsequently died from this cancer

Analysis III was as Analysis I, except that models were estimated separately for offspring whose parents (1) did not die from the cancer before or in the LYO (but may have died later), (2) died from the cancer within this period, and (3) died from the cancer specifically 0–1, 2–3, or 4–6 years after the diagnosis (but no later than the LYO). In addition, offspring in group B were included, as in all the other analysis. The estimates from (3) tell us whether offspring are affected by having a parent who has a cancer

diagnosis and who is going to die but not very soon (one cannot draw conclusions about this from Analysis I or II or the other parts of Analysis III). Sub-analyses (1) and (2) were stratified by the offspring's age when the parental cancer was diagnosed.

4.5 An extension of Analysis III: interactions with relative survival

Site- and stage-specific 5-year relative survival calculated by the Cancer Registry of Norway (2022) was dichotomized into lower than 75% (0) or higher than 75% (1). About three-quarters of the cancer cases were in the latter category. Interactions between this dummy variable and the various categories of time since diagnosis were added to a model that was estimated for offspring whose parent did not die from cancer later in the observation period (i.e., setup (1) above). Note that interactions between relative survival and current age were not included, as relative survival is not a relevant variable for those not having experienced parental cancer.

5. Results

5.1 Summary statistics

The number of 1-year observations included in Analyses I and II, and the number of individuals in groups A or A* contributing to these observations, are shown in Table 2, along with the proportions having a healthcare consultation for a mental disorder. For example, about 67,000 offspring contributed to Analysis I because they experienced a parental cancer diagnosis between the ages of 8 and 30, while about 12,000 contributed to Analysis II because they experienced a parental cancer death within this age interval.

Table 2: Number of observations and proportion with a healthcare consultation within a year in the groups included in the analyses

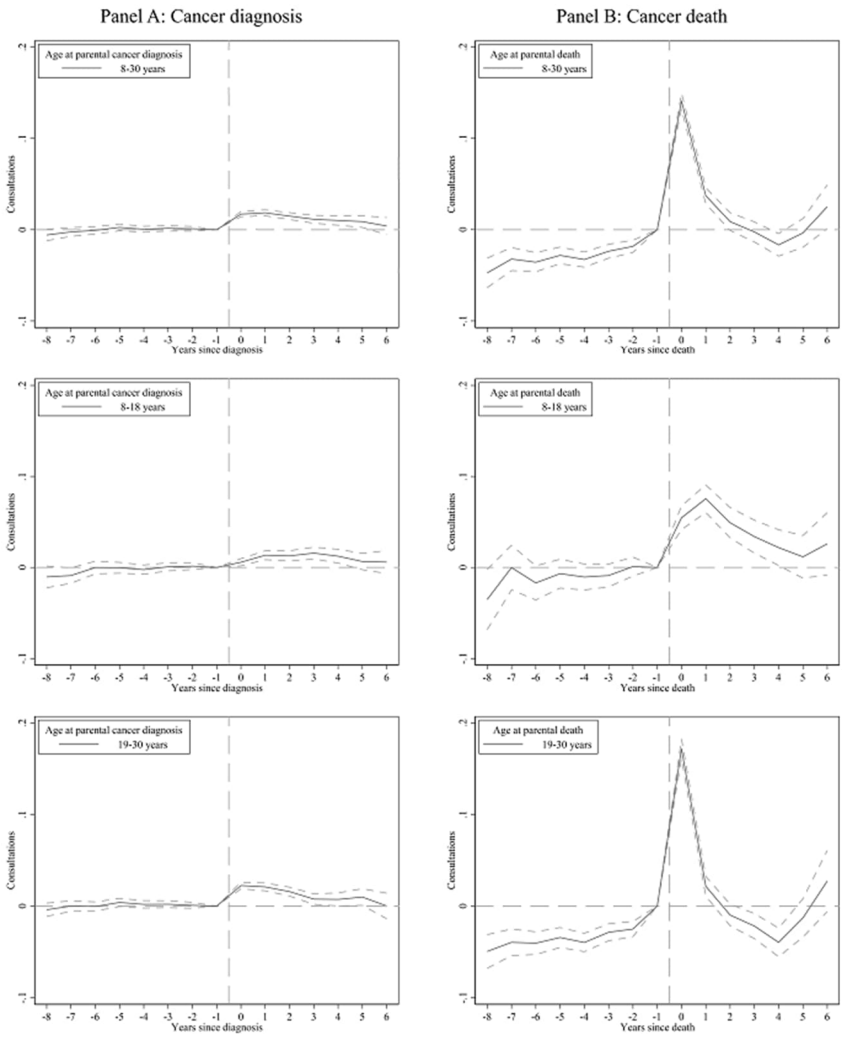
	Offspring experiencing parental cancer diagnosis (group A) or death (group A*)			Age control group (group B) [a]
	Number of 1-year observations (millions)	Number of offspring contributing to the analysis (millions)	Average value of outcome variable: proportion with a healthcare consultation for a mental disorder within a year	Number of 1-year observations (millions)
Analysis I				
Offspring aged 8–30 years at diagnosis	0.552	0.067	0.137	11.532
Offspring aged 8–18 years at diagnosis	0.179	0.021	0.103	11.532
Offspring aged 19–30 years at diagnosis	0.373	0.045	0.154	11.532
Analysis II				
Offspring aged 8–30 years at death	0.101	0.012	0.184	11.532
Offspring aged 8–18 years at death	0.027	0.003	0.129	11.532
Offspring aged 19–30 years at death	0.074	0.009	0.204	11.532

Note: [a] In this group, the proportion with a consultation is 0.118.

5.2 Effects of parental cancer diagnosis (Analysis 1)

According to the regression estimates, before a diagnosis the probability of a consultation for a mental disorder is constant: there is no clear pattern in the estimates in that period (Figure 1 and Table A-1). If the model is re-specified with a linear trend before the cancer diagnosis instead of the 7 1-year categories, the trend coefficient is essentially zero for both the youngest and the oldest age groups (0.0009 per year with standard error 0.0006 in the former group, and 0.0000 per year with standard error 0.0004 in the latter; not shown). The consultation probability increases after diagnosis in both age groups: In the youngest group there is an increase over the first years, followed by a decline to almost the same level as before the diagnosis, while in the oldest group the level is highest in the year of the diagnosis and the year afterwards.

Figure 1: Effects (with 95% CIs) of parental cancer diagnosis (panel A) and parental cancer death (panel B) on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis or death [a]



Note: [a] The models also include the offspring's age in 1-year categories. The estimates shown in the graph are also shown in Tables A-1 and A-2.

The clearly most plausible interpretation of the lack of a pre-diagnosis trend is that there is no 'anticipation' effect of the cancer before it is diagnosed, and that the age effect in the age control group (B) is the same as the age effect before diagnosis among those experiencing parental cancer (group A). If the age effects are also the same following diagnosis, the basic assumption underlying the analysis is satisfied. In other words, the development in the age control group provides a good picture of what would have happened among the offspring experiencing a parental cancer diagnosis in the absence of this event. (See further discussion of this in the subsection on robustness checks.)

In the youngest age group the coefficient for the first year after the diagnosis is 0.013, meaning that the probability of a consultation is 1.3 percentage point higher than in the year before the diagnosis, net of changes due to ageing. This corresponds to a 16% increase compared to the average consultation probability over all the years before the cancer (0.079; not shown). The confidence interval is 11%–22%. In the oldest age group the corresponding absolute increase is 0.021 and the relative increase is 15% (0.021/0.136), with confidence interval 12%–18%.

5.3 Effects of parental cancer death (Analysis II)

A parental death has a much greater effect (Figure 1, Table A-2). In both age groups there is an increase in the probability of a consultation for a mental disorder in the year of the death. In the youngest age group the increase is 5.5 percentage points, which is a 53% increase (confidence interval 39%–66%) relative to the consultation probability the year before the death (not shown in tables). There are even more consultations the year after the death, which slowly decrease afterwards to essentially the same level as in the year before the death (although the point estimates remain higher than in the period before the death). There are only weak indications of a pre-death increase.

In the oldest age group the consultation probability increases by about 4 percentage points over the three years before the death. The highest probability is in the year of the death: 0.172 above the year before the death, which is an 83% increase (confidence interval 79%–88%). Adding the pre-death increase of 0.04, which is 19% compared to the level the year before the death, this means that the consultation probability has roughly doubled over a few years. There is a sharp decline starting from the year after the death – down to the level of 4–8 years before the death – followed by an increase.

5.4 Effects of parental cancer diagnosis, conditioned on whether the parent died later (Analysis III)

It is reasonable to assume that the higher consultation probability after a parental cancer diagnosis (reported in section 5.2) is partly driven by parental death. To explore this issue we split the sample (group A) by whether the parental cancer led to death (up to LYO) or not. We also re-specified the model slightly: all years before the diagnosis were pooled together (inspired by the lack of a significant pre-diagnosis trend reported above), and categories broader than one year were used for some of the years after the diagnosis (for simplicity and because of the smaller number of observations in the split sample). The estimates from a full sample, i.e., regardless of parental death, are shown in column a of Table 3. They are of course very similar to those shown in Figure 1 and Table A-1. The estimates for offspring whose parent did not die within the observation period are shown in column b, while those for offspring whose parent died are shown in column c.

Table 3: Effects (with standard errors) of a parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis [a]

Time since cancer diagnosis (years)	a) All		b) Parent with cancer not dying from cancer later		c) Parent with cancer dying from cancer later	
Offspring aged 8–30 years at diagnosis						
≤–1 (ref)	0		0		0	
0	0.016	(0.001)	0.007	(0.001)	0.082	(0.004)
1	0.018	(0.002)	0.003	(0.002)	0.106	(0.005)
2	0.014	(0.002)	0.002	(0.002)	0.080	(0.005)
3	0.011	(0.002)	0.001	(0.002)	0.063	(0.006)
4	0.009	(0.003)	0.002	(0.003)	0.053	(0.007)
5	0.008	(0.003)	0.004	(0.003)	0.037	(0.008)
6	0.003	(0.005)	–0.002	(0.005)	0.041	(0.011)
Number of observations (millions)[b]	0.552		0.477		0.075	
Offspring aged 8–18 years at diagnosis						
≤–1 (ref)	0		0		0	
0	0.006	(0.002)	0.005	(0.002)	0.018	(0.006)
1	0.013	(0.002)	0.006	(0.002)	0.064	(0.008)
2	0.013	(0.003)	0.004	(0.003)	0.068	(0.009)
3	0.016	(0.003)	0.007	(0.003)	0.069	(0.009)
4	0.012	(0.004)	0.005	(0.004)	0.055	(0.010)
5	0.006	(0.004)	0.004	(0.005)	0.026	(0.012)
6	0.006	(0.006)	0.001	(0.007)	0.035	(0.016)
Number of observations (millions)[b]	0.179		0.157		0.021	
Offspring aged 19–30 years at diagnosis						
≤–1 (ref)	0		0		0	
0	0.021	(0.002)	0.008	(0.002)	0.105	(0.005)
1	0.020	(0.002)	0.001	(0.002)	0.123	(0.006)
2	0.015	(0.002)	0.001	(0.002)	0.084	(0.006)
3	0.006	(0.003)	–0.002	(0.003)	0.055	(0.007)
4	0.006	(0.003)	–0.001	(0.004)	0.046	(0.009)
5	0.009	(0.005)	0.005	(0.005)	0.038	(0.011)
6	–0.001	(0.007)	–0.006	(0.008)	0.035	(0.016)
Number of observations (millions)[b]	0.373		0.319		0.053	

Notes: [a] The model also includes the offspring's age in 1-year categories.
[b] Excluding the age control group (group B).

Small increases in the consultation probability are seen after the diagnosis even if the parent did not die (column b): In the youngest age group the consultation probability is raised by 0.005–0.007 for some years after the diagnosis, while in the oldest age group there is an increase of about the same absolute size in the year of the diagnosis (but not later). To turn this into a relative measure, an increase of 0.006 is only 5% of the level in the years before the diagnosis. These effects are substantially smaller than those found when the bereaved offspring are included (column a). In other words, our results suggest that bereavement is an important driver – but not the only driver – of the effect of a parental cancer diagnosis on consultations.

As one would expect, there are much sharper increases in the consultation probability from the year of the diagnosis if the parent died (column c). However, according to further analysis stratified by the number of years between diagnosis and death (and pooling all ages at diagnosis to improve precision), there is no increase in consultations soon after the diagnosis unless the death occurs within 3 years. If death occurs 4–6 years after the diagnosis, the consultation probability remains constant at the pre-diagnosis level over the first three years (Table 4).

Table 4: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30 if the parent also died from the cancer, by time between diagnosis and death [a]

Time since cancer diagnosis (years)	Cancer death 0–1 year after diagnosis		Cancer death 2–3 years after diagnosis		Cancer death 4–6 years after diagnosis	
Offspring aged 8–30 years at diagnosis						
≤–1 (ref)	0		0		0	
0	0.110	(0.005)	0.025	(0.007)	–0.005	(0.013)
1	0.143	(0.006)	0.038	(0.008)	0.003	(0.015)
2–3	0.051	(0.006)	0.126	(0.009)	0.002	(0.013)
4–6	0.027	(0.007)	0.040	(0.010)	0.090	(0.017)
Number of observations (millions)[b]	0.050		0.018		0.005	

Notes: [a] The model also includes the offspring's age in 1-year categories.
[b] Excluding the age control group (group B).

5.5 Interactions with relative survival (an extension of Analysis III)

Our next step was to examine how the severity of the cancer, as indicated by relative survival, impacted the offspring's response. In this analysis we included only offspring whose parent survived up to the LYO (i.e., the group for whom estimates were shown in column b of Table 3).

Note first that when interactions with relative survival are added, the main effects reflect the response to those cancers expected to be most harmful (relative survival <

75%). We see in Table 5 that with such cancers there is a much clearer post-diagnosis increase in the consultation probability in the oldest age group than was found when all cancers were pooled regardless of relative survival (column b of Table 3). Furthermore, the interaction effects are negative (Table 5), and the sum of the main and interaction effects (which are the effects for the cancers with the best prognosis) are almost zero. In other words, there is an increase in consultations after a parental cancer diagnosis if the survival prospects are relatively poor, but no increase if they are better. Because of the larger size of the latter group, the 'overall' effects (shown in column b of Table 3) are weak.

For the youngest age group, the estimates suggest that there are neither main effects nor interaction effects (Table 5). However, the sum of the main and interaction effects, which are the effects of the cancer cases with a relatively good prognosis, are more clearly positive (according to models estimated specifically for this group of cancers; not shown). Again, this group is the largest, which fits with the (weak) effects appearing when all cases of parental cancer are pooled together regardless of survival prospects (column b of Table 3). In other words, there is no clear evidence of effects of cancer with poor prognosis on the consultation probability, but there are weak adverse effects of the larger group of presumably less harmful cancers. This is opposite to the pattern observed in the older age group.

Table 5: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30 if the parent did not die from the cancer, by their age at the time of diagnosis [a]

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
Main effects						
≤–1 (ref)	0		0		0	
0	0.021	(0.004)	0.008	(0.006)	0.026	(0.005)
1	0.009	(0.005)	0.003	(0.007)	0.012	(0.006)
2–3	0.012	(0.005)	–0.001	(0.008)	0.019	(0.006)
4–6	0.015	(0.008)	0.015	(0.012)	0.013	(0.010)
Interactions with whether relative survival is higher than 75%						
≤-1 (ref)	0		0		0	
0	–0.016	(0.004)	–0.004	(0.006)	–0.021	(0.005)
1	–0.007	(0.005)	0.004	(0.007)	–0.013	(0.006)
2–3	–0.011	(0.005)	0.007	(0.008)	–0.022	(0.007)
4–6	–0.015	(0.008)	–0.013	(0.012)	–0.014	(0.011)
Number of observations (millions) [b]	0.477		0.157		0.319	

Notes: [a] The model also includes the offspring's age in 1-year categories.
[b] Excluding the age control group (group B).

5.6 Robustness tests

Several robustness checks were made. First, instead of estimating the age effects from the age control group (B), and assuming the same age effects among those experiencing a parental cancer diagnosis (group A), we omitted the age control group and pooled all years before the diagnosis. This means that we assume no effect of the time up to the diagnosis, so that all variation in the consultation probability before the diagnosis is a result of the offspring getting older. In other words, we estimated the age effects from the pre-diagnosis observations. This gave very similar estimates (Table A-3).

In our second robustness check, which may also be considered as a small extension of the analysis, we added one group: offspring of parents diagnosed with cancer between the year when they were 8 years old and FYO+1. This approach increased the number of observations for time ≥–1 (thus improving precision), and also allowed us to analyse the health response at time > 6 (up to 22 if the diagnosis took place at ages 8–18, but only up to 11 if it took place at ages 19–30). These individuals were not included in the main analysis because they do not contribute to the estimation of the effects of time < –1, so we cannot be sure that the age assumption holds for them.

Because of the extended observation period, the linear term $\zeta_1 T_6(t\text{-}6)$ was added to the model. T_6 is 1 if t > 6 and 0 otherwise, and ζ_1 thus represents the linear annual change more than 6 years after the diagnosis compared to the level at 6 years. The results from these models (Table A-4) were very similar to those in the main analysis, but there was a decline after 6 years in the youngest age group.

A corresponding analysis of the effects of time since death (i.e., including deaths before FYO+2) showed a pattern that was somewhat different from that in the main analysis: There was less variation in the consultation probability some years after a parental cancer death in the oldest age group (Table A-5). Rather than going down to the level observed 4–8 years before the death and then up again (Figure 1, Table A-2), the point estimates remained quite constant from about 3 years after death, at a level above that observed 4–8 years before death. There was no clear linear trend from 6 years after the death, but indications of a decline.

In a third robustness check, we considered a shorter observation period (from our first year of observation, FYO, to a year LYO*), and used as the age control group offspring whose parent was diagnosed with cancer after this period (i.e., between LYO*+1 and our last year of observation, LYO). By contrast, the age control group in the main analysis included offspring whose parent had not been diagnosed with cancer by LYO, several of whom may not experience a parental cancer diagnosis for many years, if ever. With the latter control group there would, in principle, be more doubt about the key assumption regarding similar age effects, although the first robustness check clearly supported this assumption.

More specifically, a new LYO* was set to the original LYO less 3; i.e., the focus was on a parental cancer diagnosis between FYO+2 and LYO* and the consultation probabilities between FYO and LYO*. Offspring experiencing parental cancer diagnosis from LYO-2 to LYO were included in a new version of the age control group, with a focus on their consultation probabilities from FYO to LYO*. With this setup – where only the period from 5 years before diagnosis to 3 years afterwards could be considered – the increase in consultations after the diagnosis was quite similar to that estimated in the main analysis (Table A-6). Note that it would not be reasonable to do a similar analysis of time since cancer death, because those definitely experiencing a parental death after LYO* may already be on an upward trend in consultations before that, which would be wrongly taken as an age effect.

Finally, if the offspring included in the analysis had one or more maternal siblings, we selected one of the siblings at random. The estimates from this much smaller sample (Table A-7) were similar to those in the main analysis.

6. Discussion and conclusions

6.1 Synthesizing and interpreting the main results

We have expanded on the literature by combining two steps. First, we controlled for all time-constant factors in a dynamic individual fixed-effects analysis, as in only one previous study (Kristiansen 2021). Second, and unlike that study and most others, we separated the effects of illness and death, and even considered the time to death. More specifically, we distinguished between the mental health effects of parental cancer death – including forthcoming death – and the mental health effects that parental cancer may have when the death is further away in time, or when the parent remains alive until the end of the observation period (but may die later). In the latter cases the parent may be weakened by the disease and spend extensive time in treatment, so that fewer resources are available to the offspring, and the offspring may also be worried about the situation or be disadvantaged for other reasons (see elaboration above).

Our analysis suggests that these effects of parental cancer diagnosis, absent death, are weak. While the probability of a healthcare consultation for a mental health problem is raised by about 15% after a parental cancer diagnosis in both age groups, the increase is considerably smaller (the relative increase being only about 5%) when the analysis is conditioned on survival through the remaining observation period. In fact, in the oldest age group the consultation probability is only elevated in the year of the diagnosis. Furthermore, according to the analysis of the much smaller group of offspring who do experience a parental cancer death within the observation period, and for whom we

therefore know the time between diagnosis and death, there is no increase in the consultation probability in the first couple of years after the diagnosis (for the two age groups combined) if the death occurs 4–6 years after the diagnosis.

A more marked response to a diagnosis might be expected if the survival prospects, as indicated by the published relative survival from the type of cancer the parent has, are particularly poor. This expectation is to some extent supported by the estimates for the oldest age group: Among offspring whose parent survive throughout the observation period, in the cases where survival prospects are poor there is a markedly higher probability of a consultation after the diagnosis than before. The pattern is different when the survival prospects are better, according to the interaction effects. In fact, in the latter case the consultation probability does not increase after the cancer diagnosis. However, it is not obvious how these results should be interpreted. They may reflect that in situations where the parent with cancer is (still) not very affected, the family may be more worried if the prognosis is poor than if it is not. Alternatively, if the prognosis is poor it is also particularly likely that a death will take place shortly after the observation period, so that the last years of that period include the very challenging pre-death stage. An opposite pattern appears in the youngest age group, where only the cancers with the best prognosis have effects, although these effects are weak.

As expected, we see sharper changes in consultations for mental health disorders around the time of death. In the oldest age group there is an increase over the few years before death – when the worries and other burdens the offspring experienced earlier in the illness period may have become more intense. There are only weak indications in this direction in the youngest age group. However, in both groups there is an immediate response to the death: Compared to the year before death, the consultation probability increases 53% in the younger group and 83% in the older group (after a 19% increase in the latter prior to death). However, in the subsequent period there is a steeper decline among the oldest. Nevertheless, in both age groups the point estimates indicate that the consultation probability is higher 5–6 years after death than a couple of years before death.

To summarize the age pattern, the effects of a parental cancer diagnosis that appear when it is conditioned on survival are weak in both age groups, while there are age differences in the effects of a death or an approaching death. These age differences may reflect that the older offspring are more involved as supporters or caregivers shortly before the parent's death and can more easily grasp the definitive loss, while also adapting more quickly to the new life situation afterwards. All in all, the findings suggest that healthcare personnel should perhaps pay more attention to young adults with parents in the terminal stages of cancer and after the death. We return to that below.

6.2 Strengths and limitations

In addition to the statistical method used, and the distinction made between illness and death, the strength of this analysis lies in the use of a large data set that includes objective measures of healthcare usage. It should also be noted that the main findings are robust to some alternative model specifications.

One challenge with the outcome variable is that, in principle, the number of healthcare consultations reflects both actual health and the inclination to seek professional help for a health problem. Torvik et al. (2018) find that a large proportion of the individuals who meet diagnostic criteria for depression or anxiety in a clinical interview have consulted a GP in the two preceding years and have been recorded as having a mental disorder. A smaller proportion have been registered with such a diagnosis in specialized healthcare. However, a sizeable minority have not contacted medical experts. Presumably, those with relatively mild symptoms are particularly likely to be in this category.

To the extent that an individual's tendency to seek professional help for a health problem is constant over time this is captured by the individual fixed effects. However, there are likely to be variations over time in the propensity to seek help and, most importantly, it is possible that a parent's cancer diagnosis or death changes it. This kind of bias could go both ways. On the one hand, the offspring's threshold for seeking help may become lower as a result of their parent's more frequent use of healthcare; or friends or family members may encourage them to seek help because of particular concern about their well-being after a parent is diagnosed with cancer or dies. In other words, it is possible that some of the effect that we estimate is actually the result of such increases in seeking healthcare rather than a deterioration in health. On the other hand, when there is distress in the family because of cancer, the parents may be less likely to find time to take a child to a doctor if they suspect a health problem. Furthermore, relatively old offspring may be so preoccupied with the well-being of the parent who is ill or (especially after a death) the other parent that they pay less attention to their own health problems. If this is the case, the actual health response to parental cancer may be stronger than our estimates suggest. Another reason for a possible underestimation of the mental health response is that some of it may be the result of an increase in relatively mild symptoms that many people generally do not seek help for (under any circumstances). In principle, the mental health effect will also be underestimated if young offspring receive professional help at a healthcare institution that treats the parent, but this is not registered as a consultation in the NPR.

An alternative outcome variable would be a count variable for the number of consultations, rather than our distinction between 0 versus 1 or more. However, it is not obvious what a larger number of consultations (beyond 1) would signal. For example, multiple treatments in specialized healthcare within a year may indicate a particularly

severe disorder, but it may also indicate the opposite, as the treatment for some severe disorders might be delivered during one long hospital stay. Also, it is not clear whether, for example, two GP consultations within a year signal a more severe or less severe disorder than one consultation in specialized healthcare.

There is also the question of whether there is reason for concern about time-varying confounders. For example, the health of the parent without cancer, support from family members, and economic resources may influence the development of the disease after diagnosis as well as the probability of dying from it, and may also impact the offspring's mental health. However, some of these factors may also be affected by the disease or death. Consequently, if they were included we would not know whether we had come closer to a causal effect of parental cancer, or whether we had 'over-controlled', in the sense that the remaining effects of parental cancer only reflect causal pathways not involving the respective control variables. Our decision was to estimate models without any time-varying characteristics except age and time since parental cancer diagnosis or death.

6.3 Concluding remarks

To conclude, our results suggest that parental cancer influences offspring's mental health primarily through bereavement. Both younger and older offspring are markedly affected by a death or (at least for the older offspring) an approaching death. The point estimates indicate that there may be a mental health disadvantage lasting at least 5–6 years after death. To the extent that this effect persists beyond our observation period, it can be said that the effect of parental cancer is long-term, like some other aspects of the early-life environment (e.g., Heckman 2012).

The evident effect of death may be considered as justifying the current law in Norway, which requires healthcare institutions to pay attention not only to offspring with a parent who is seriously ill, but also to those who have experienced parental death. However, it is perhaps easier to provide high-quality help at this stage if good contact with the offspring has already been established early in the illness period, even though – according to our results – they may not be so strongly affected then.

While older offspring may adapt more quickly to a parental death than younger offspring, and the generally weak response to a parental diagnosis of cancer that has not (yet) led to death is particularly weak for the older group, they also have the strongest response to forthcoming and recent death. One may therefore say that on the whole parental cancer does not appear to be less harmful to young adults' mental health than to that of younger offspring. This is noteworthy in the light of the aforementioned law,

which is restricted to offspring under 18 years of age. However, both age groups may receive good support from friends, family members, and others in their social network.

Our conclusions about the effects of parental cancer are likely to have broad relevance. In particular, it is hard to believe that such an event has much less impact on children and young adults in other countries, unless the formal and informal support systems are considerably better. Furthermore, mental health responses to other long-lasting, serious diseases among parents, and to death from such diseases, may be similar, although the effects of more unexpected deaths may be different.

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Ethical approval
Ethical approval to use the data for this research purpose has been provided by the data owners and the Regional Committees for Medical Research Ethics (REK number 2018/434)

Data statement
The access to the data is highly restricted. The data can only be used in collaboration with researchers at the Centre for Fertility and Health, and for certain purposes described in the protocol approved by the Regional Committees for Medical Research Ethics.

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Appendix

Table A-1: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis [a]

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
–8	–0.006	(0.003)	–0.010	(0.006)	–0.004	(0.004)
–7	–0.002	(0.002)	–0.009	(0.004)	0.000	(0.003)
–6	–0.001	(0.002)	0.000	(0.004)	0.004	(0.002)
–5	0.003	(0.002)	0.000	(0.003)	0.002	(0.002)
–4	0.001	(0.002)	–0.002	(0.003)	0.002	(0.002)
–3	0.002	(0.001)	0.001	(0.002)	0.002	(0.002)
–2	0.001	(0.001)	0.001	(0.002)	0.001	(0.002)
–1 (ref)	0		0		0	
0	0.017	(0.001)	0.006	(0.002)	0.022	(0.002)
1	0.019	(0.002)	0.013	(0.003)	0.021	(0.002)
2	0.015	(0.002)	0.013	(0.003)	0.016	(0.002)
3	0.011	(0.002)	0.016	(0.003)	0.008	(0.003)
4	0.010	(0.003)	0.012	(0.004)	0.007	(0.004)
5	0.009	(0.003)	0.007	(0.005)	0.010	(0.005)
6	0.004	(0.005)	0.006	(0.006)	0.000	(0.007)

Note: [a] The model also includes the offspring's age in 1-year categories.

Table A-2: Effects (with standard errors) of parental cancer death on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of death [a]

Time since cancer death (years)	Offspring aged 8–30 years at death		Offspring aged 8–18 years at death		Offspring aged 19–30 years at death	
–8	–0.047	(0.008)	–0.035	(0.017)	–0.049	(0.009)
–7	–0.032	(0.006)	0.000	(0.012)	–0.039	(0.007)
–6	–0.036	(0.005)	–0.017	(0.010)	–0.040	(0.006)
–5	–0.028	(0.005)	–0.007	(0.008)	–0.034	(0.006)
–4	–0.033	(0.004)	–0.010	(0.007)	–0.040	(0.005)
–3	–0.024	(0.004)	–0.009	(0.006)	–0.029	(0.005)
–2	–0.018	(0.003)	0.001	(0.005)	–0.025	(0.004)
–1 (ref)	0		0		0	
0	0.141	(0.004)	0.055	(0.007)	0.172	(0.005)
1	0.037	(0.004)	0.076	(0.008)	0.022	(0.005)
2	0.009	(0.005)	0.049	(0.008)	–0.010	(0.006)
3	–0.002	(0.006)	0.034	(0.009)	–0.022	(0.007)
4	–0.017	(0.006)	0.022	(0.010)	–0.040	(0.008)
5	–0.003	(0.008)	0.012	(0.012)	–0.013	(0.011)
6	0.025	(0.012)	0.026	(0.017)	0.027	(0.017)

Note: [a] The model also includes the offspring's age in 1-year categories.

Table A-3: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis [a]

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
As the first column of Table 3						
≤–1 (ref)	0		0		0	
0	0.016	(0.001)	0.006	(0.002)	0.021	(0.002)
1	0.018	(0.002)	0.013	(0.002)	0.020	(0.002)
2	0.014	(0.002)	0.013	(0.003)	0.015	(0.002)
3	0.011	(0.002)	0.016	(0.003)	0.006	(0.003)
4	0.009	(0.003)	0.012	(0.004)	0.006	(0.003)
5	0.008	(0.003)	0.006	(0.004)	0.009	(0.005)
6	0.003	(0.005)	0.006	(0.006)	–0.001	(0.007)
As above, but excluding the age control group (group B)						
≤–1 (ref)	0		0		0	
0	0.016	(0.001)	0.003	(0.002)	0.021	(0.002)
1	0.017	(0.002)	0.009	(0.003)	0.019	(0.003)
2	0.013	(0.002)	0.008	(0.004)	0.014	(0.003)
3	0.009	(0.003)	0.012	(0.005)	0.005	(0.004)
4	0.008	(0.003)	0.011	(0.006)	0.005	(0.005)
5	0.006	(0.004)	0.007	(0.007)	0.007	(0.006)
6	0.001	(0.005)	0.006	(0.009)	–0.002	(0.008)

Note: [a] The model also includes the offspring's age in 1-year categories.

Table A-4: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis, when offspring experiencing the diagnosis between age 8 and FYO+1 are also included [a]

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
≤ –1 (ref)	0		0		0	
0	0.017	(0.001)	0.006	(0.002)	0.022	(0.002)
1	0.017	(0.001)	0.012	(0.002)	0.020	(0.002)
2	0.014	(0.002)	0.014	(0.002)	0.014	(0.002)
3	0.009	(0.002)	0.013	(0.003)	0.005	(0.002)
4	0.007	(0.002)	0.012	(0.003)	0.002	(0.003)
5	0.006	(0.002)	0.007	(0.003)	0.004	(0.003)
6	0.007	(0.002)	0.011	(0.003)	0.000	(0.003)
Linear effect from 6, i.e., effect of the term (time-6), which is added for time ≥ 6 [b]	–0.0008	(0.0004)	–0.0009	(0.0004)	–0.0010	(0.0013)
Number of observations (million) among those who have experienced parental cancer diagnosis (group A)	0.952		0.431		0.521	
Number of observations (million) in age control group (group B)	11.532		11.532		11.532	

Notes: [a] The model also includes the offspring's age in 1-year categories.
[b] The analysis of offspring experiencing a parental cancer diagnosis at ages 19–30 only covers the period up to 11 years after the diagnosis, while the other analyses cover the period up to 22 years after the diagnosis.

Table A-5: Effects (with standard errors) of parental cancer death on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of death, when offspring experiencing the death between age 8 and FYO+1 are also included, unless the diagnosis was prior to one year after the child's birth [a]

Time since cancer death (years)	Offspring aged 8–30 years at death		Offspring aged 8–18 years at death		Offspring aged 19–30 years at death	
–8	–0.048	(0.008)	–0.037	(0.017)	–0.050	(0.009)
–7	–0.033	(0.006)	–0.003	(0.012)	–0.040	(0.007)
–6	–0.037	(0.005)	–0.020	(0.010)	–0.041	(0.006)
–5	–0.029	(0.005)	–0.010	(0.008)	–0.035	(0.005)
–4	–0.034	(0.004)	–0.013	(0.007)	–0.040	(0.005)
–3	–0.024	(0.004)	–0.012	(0.006)	–0.029	(0.005)
–2	–0.019	(0.003)	–0.002	(0.005)	–0.026	(0.004)
–1 (ref)	0		0		0	
0	0.138	(0.004)	0.053	(0.006)	0.169	(0.005)
1	0.034	(0.004)	0.068	(0.007)	0.020	(0.005)
2	0.008	(0.004)	0.041	(0.007)	–0.009	(0.005)
3	0.001	(0.004)	0.034	(0.007)	–0.018	(0.006)
4	–0.004	(0.005)	0.022	(0.007)	–0.022	(0.006)
5	–0.008	(0.005)	0.014	(0.008)	–0.023	(0.007)
6	–0.004	(0.005)	0.019	(0.008)	–0.018	(0.007)
Linear effect from 6, i.e., effect of the term (time-6) which is added for time ≥ 6 [b]	–0.0016	(0.0009)	–0.0013	(0.0009)	–0.0040	(0.0026)
Number of observations (million) among those who have experienced parental cancer death (group A*)	0.195		0.085		0.111	
Number of observations (million) in age control group (group B)	11.532		11.532		11.532	

Notes: [a] The model also includes the offspring's age in 1-year categories.
[b] The analysis of offspring experiencing a parental cancer death at ages 19-30 only covers the period up to 11 years after the death, while the other analyses cover the period up to 22 years after the death.

Table A-6: Effects (with standard errors) of parental cancer diagnosis on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of diagnosis, when only consultations up to LYO-3 are considered, the diagnosis takes place up to this year, and group B only includes individuals with a parental cancer diagnosis between LYO-2 and LYO [a]

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
–5	0.003	(0.004)	0.002	(0.006)	0.004	(0.005)
–4	0.004	(0.003)	0.004	(0.004)	0.004	(0.004)
–3	0.005	(0.002)	0.006	(0.003)	0.005	(0.003)
–2	0.001	(0.002)	0.003	(0.003)	0.001	(0.003)
–1 (ref)	0		0		0	
0	0.012	(0.002)	0.003	(0.003)	0.019	(0.003)
1	0.018	(0.003)	0.014	(0.004)	0.022	(0.004)
2	0.015	(0.003)	0.009	(0.005)	0.021	(0.005)
3	0.009	(0.005)	0.014	(0.007)	0.002	(0.007)
Number of observations (million) among those who have experienced parental cancer diagnosis (group A)	0.166		0.069		0.097	
Number of observations (million) in age control group (group B)	0.186		0.186		0.186	

Note: [a] The model also includes the offspring's age in 1-year categories.

Table A-7: Effects (with standard errors) of parental cancer diagnosis or death on offspring's probability of having a healthcare consultation for a mental disorder at ages 6–30, by their age at the time of the event, when only one child is included for each mother based on a random selection [a]

Panel A: Effects of time since parental cancer diagnosis

Time since cancer diagnosis (years)	Offspring aged 8–30 years at diagnosis		Offspring aged 8–18 years at diagnosis		Offspring aged 19–30 years at diagnosis	
≤-1 (ref)	0		0		0	
0	0.017	(0.002)	0.004	(0.002)	0.023	(0.003)
1	0.019	(0.002)	0.012	(0.003)	0.020	(0.003)
2	0.015	(0.003)	0.014	(0.003)	0.012	(0.003)
3	0.012	(0.003)	0.015	(0.004)	0.006	(0.004)
4	0.012	(0.004)	0.013	(0.005)	0.004	(0.005)
5	0.013	(0.005)	0.006	(0.006)	0.014	(0.006)
6	0.013	(0.007)	0.002	(0.008)	0.006	(0.009)

Panel B: Effects of time since parental cancer death

Time since cancer death (years)	Offspring aged 8–30 years at death		Offspring aged 8–18 years at death		Offspring aged 19–30 years at death	
–8	–0.046	(0.011)	–0.041	(0.020)	–0.042	(0.013)
–7	–0.030	(0.009)	–0.018	(0.015)	–0.038	(0.010)
–6	–0.030	(0.008)	–0.017	(0.012)	–0.042	(0.008)
–5	–0.023	(0.007)	–0.011	(0.010)	–0.028	(0.008)
–4	–0.033	(0.006)	–0.012	(0.009)	–0.037	(0.007)
–3	–0.021	(0.005)	–0.008	(0.008)	–0.026	(0.006)
–2	–0.016	(0.005)	0.001	(0.007)	–0.024	(0.006)
–1 (ref)	0		0		0	
0	0.155	(0.006)	0.055	(0.009)	0.172	(0.007)
1	0.038	(0.006)	0.074	(0.010)	0.028	(0.007)
2	0.015	(0.007)	0.044	(0.011)	–0.010	(0.008)
3	0.011	(0.008)	0.031	(0.012)	–0.022	(0.010)
4	–0.005	(0.009)	0.018	(0.012)	–0.041	(0.011)
5	0.006	(0.011)	0.006	(0.015)	–0.018	(0.014)
6	0.044	(0.017)	–0.001	(0.020)	0.028	(0.022)

Note: [a] The models also include the offspring's age in 1-year categories.